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Product Market Competition and Executive Compensation: An Empirical Investigation

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There is an ongoing theoretical debate about whether firm-owners would optimally use stronger or weaker incentive schemes for their managers as product market competition increases. Schmidt (1997) shows that the outside options of the managers play a crucial role: if the market for managers is soft, an increase in competition is more likely to result in stronger incentive schemes than if the market for managers is tough. In this paper, we for the first time analyze the effect of product market competition on the level and structure of executive compensation. With panel-data for firms in the the U.S. manufacturing industries (NAICS 32-33), we investigate (a) how an increase in product market competition affects the use of incentive contracts and (b) whether this relationship depends on the outside options of the managers as predicted by theory.

JEL Classification: G3, J3, L2.

Key Words: CEO compensation, product market competition, incentive schemes.

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Abstract

There is an ongoing theoretical debate about whether firm-owners would optimally use stronger or weaker incentive schemes for their managers as product market competition increases. Schmidt (1997) shows that the outside options of the managers play a crucial role: if the market for managers is soft, an increase in competition is more likely to result in stronger incentive schemes than if the market for managers is tough. In this paper, we for the first time analyze the effect of product market competition on the level and structure of executive compensation. With panel-data for firms in the the U.S. manufacturing industries (NAICS 32-33), we investigate (a) how an increase in product market competition affects the use of incentive contracts and (b) whether this relationship depends on the outside options of the managers as predicted by theory.

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1 Introduction

There is a growing theoretical debate about the effects of product market competition on managerial effort and firm owners' use of incentive schemes. While the earlier literature speculates that insufficient competition leads to managerial slack,[1] Hart (1983) was one of the first to *formalize* the idea that competition reduces managerial slack.[2] However, subsequent research showed that the relationship between competition and managerial slack becomes ambiguous as soon as Hart's assumption of infinitely risk averse managers is abandoned (Scharfstein, 1998).[3]

While most of the papers focus on the *information effects* of competition (i.e. the idea that competition helps a principal to make better inferences about his agent's actions), Schmidt (1997) investigates the interactions between product market competition and incentives of managers *without* relying on such information effects. In his setup, increased competition reduces the firm's profit, which induces the manager to work harder for a cost reduction in order to avoid liquidation. However, the reduction in profits also affects the profitability of a cost reduction, which may have an ambiguous effect on manager's work effort.

As for the effect of competition on managerial effort and executive compensation, Schmidt (1997) is in line with other papers by showing that this relationship is ambiguous and depends on different effects. However, in contrast to previous research, Schmidt (1997) shows that the outside options of the managers play a crucial role in determining the sign of the total effect. Specifically, if the market for managers is

[1] According to Leibenstein (1966), there may be a substantial amount of X-inefficiency if output markets are imperfectly competitive. Also, he argues that that this type of inefficiency is much more important in practice than more conventional sorts of inefficiencies due to prices not being equal to marginal costs. Machlup (1967) notes that managerial slack as an inefficiency source does not exist if a firm operates in a perfectly competitive environment. However, Jensen and Meckling (1976) claim that a monopolist has the same incentives to reduce agency costs than an owner of a perfectly competitive firm.

[2] He develops a model of the relationship between competition and slack in a situation where inefficiency is explicitly the result of a conflict of interest between owners and managers. Since firm owners cannot monitor managerial actions and are also uncertain about their costs, they do not know whether a bad performance of the firm is due to mismanagement or high costs. Given the fact that the firms' costs are positively correlated, lower costs lead to lower prices. It follows that managers who must fulfill profit targets will have less opportunity to engage in managerial slack than if their costs alone had fallen without a change in the output prices.

[3] Hermalin (1992) considers two other effects, competition might have on a firm's agency problem, namely the risk-adjustment effect and the change-in-relative-value-of-action effect. Overall, Hermalin (1992) finds that each of these effects is of potentially ambiguous sign. He concludes that theory does not offer a definitive defense of the presumption that increased competition reduces managerial slack.

tough, an increase in competition is less likely to result in stronger incentive schemes than if the market for managers is soft. This feature of the model allows us to empirically discriminate these different cases, which makes it attractive for an empirical test.

The aim of our paper is to *empirically* investigate the effect of competition on executive compensation. Besides looking at the level of compensation, we for the first time consider various measures which characterize the structure of executive compensation and which give a more complete picture of the incentives the executives are facing.[4] In addition, we explicitly take into account whether the bargaining power of the managers affects the relationship between competition and executive compensation, as predicted by Schmidt's (1997) model.

The data set is a panel for firms in the US manufacturing industries over the years 1992 to 2000. While data on executive compensation and firm characteristics are taken from the Compustat Executive database and Compustat Industrial Annual database, we first have to build measures for the intensity of competition.

For each sub-industry in the industries 32 and 33 (NAICS 3 digit-level), we estimate an intensity of competition measure as suggested by Boone and Weigand (2000). The advantage of the Boone-Weigand Indicator, compared to traditional competition measures (e.g. concentration ratio, industry profitability) is that it not only captures competition going together with more firms in the market, but also competition resulting from more aggressive behavior of the firms in the industry.[5] However, we also employ the price-cost margin as an alternative measure of competition.

Using these two measures of competition, we find the following relationship between competition and executive compensation: The relationship between competition and

[4]There are a two related papers, which focus on the strategic effect of compensation schemes. Aggarwal and Samwick (1999), for instance, test for the effects of competition on relative performance evaluation in executive compensation contracts. As such, the focus is on the *joint impact* of competition and (own- and rival-firm) performance on compensation; in contrast, the effect of competition on the level and structure of compensation can hardly be tested, since there is no variation of the competition measure over time (Aggarwal and Samwick (1999) use the Herfindahl-Index in the different industries for the year 1992). Kedia (1998), on the other hand, investigates how firms use incentive contracts in order to alter product market behavior. Therefore, the analysis focuses on the effect of compensation contracts on competition and not, as in our analysis, on the effects of a changing intensity of competition on the level and structure of compensation.

[5]The basic idea is to empirically estimate how changes in efficiency (relative costs) are reflected in changed profits. For instance, if competition in an industry is low, an increase in costs may not reduce profits, whereas the opposite holds true under tough competition.

executive compensation differs between the industries. In industry 32, an increase in the intensity of competition led to a decrease in compensation as well as to the use of weaker incentive schemes. In contrast, the opposite was observed in industry 33. For both industries, however, we find that with increasing outside options of the managers (measured by the growth rate of the Dow Jones Index and a measure of the CEO's past performance), an increase in competition led to higher executive compensation (especially in the variable part of the salary).

Therefore, our results are consistent with the literature which posits an ambiguous relationship between competition and executive compensation, but predicts that increasing outside options of the managers positively affect this relationship.

The main innovations of the paper can be summarized as follows. It is the first paper which empirically investigates the relationship between executive compensation and product market competition while explicitly taking into account the outside option of managers. In addition, we use a new concept to measure the intensity of product market competition which overcomes the ambiguity problems of the conventional competition measures.

The rest of the paper is structured as follows: Section 2 contains Schmidt's (1997) theoretical model and our derivation of a testable hypothesis. Section 3 describes the concepts to measure the intensity of competition on product markets and shows the estimates for the different sub-industries. The econometric model, which relates competition to executive compensation, is presented in section 4, and section 5 contains the results. Section 6 concludes. Some supplementary materials can be found in the appendix.

2 The model

Subsections 2.1. to 2.2. outline the theoretical model which goes back to Schmidt (1997). As is described in section 2.3., we use Schmidt's model in order to derive a testable hypothesis for the empirical section of the paper. The reader familiar with Schmidt's model can skip the first two subsections and directly go to subsection 2.3, where the effect of competition on the compensation contract is derived or subsection 2.4, where the results are summarized and the testable hypothesis is outlined.

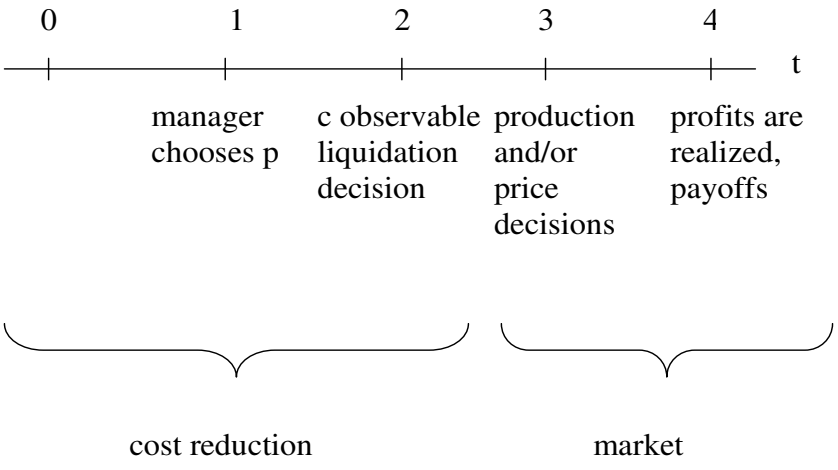
2.1 The basic setup

Schmidt (1997) considers the following model: At date $t = 0$, the owner of the firm hires a manager for the CEO position on a competitive market for identical managers. The owner of the firm and the manager are risk neutral. The manager's job is to improve the efficiency of the firm by reducing the future production costs. The cost function is characterized by a parameter c, with $c \in \left\{c^L, c^H\right\}$ and $c^H > c^L$. Initially, the firm is characterized by a high cost parameter c^H. At date $t = 1$, the manager chooses his effort level. The probability that the manager's activities lead to a cost reduction is a function of his effort, i.e., by exerting effort, the manager increases the probability p that a cost reduction takes place and that the technology switches to the low cost parameter c^L. The effort of the manager is unobservable. The manager chooses p, with $p \in [0, 1]$, at personal costs $G(p)$ which increase with p at an increasing rate, i.e., $G'(p) > 0, G''(p) > 0$ with $G(0) = G'(0)$ and $\lim_{p \to 1} G(p) = \infty$.

At date $t = 2$, the realization of c becomes publicly observable. The owner of the firm then decides whether to stay in the market and to compete with its rivals, or to exit the market and liquidate the firm. In the latter case, the liquidation value of the firm is normalized to zero. At date $t = 3$, in case the firm still is in the market, production takes place and profits π are realized.

Figure 1 resumes the structure of the game.

Figure 1: Structure of the game



As for the third stage of the game, Schmidt (1997) does not explicitly model the market game, but assumes that it has a unique equilibrium and that the reduced-form gross profit function is given by

$$\pi = \pi(c, \phi, \varepsilon) \tag{1}$$

where ϕ measures the degree of product market competition in the market and ε is an exogenous noise variable. The degree of product market competition ϕ, with $\phi \in \Phi \in R$, is a continuous variable which can reflect the number of competitors in the market, whether the firms compete in prices or in quantities, the degree of product differentiation or any other indicator of the intensity of competition. The exogenous noise variable ε, with $\varepsilon \in R$, is distributed according to the cumulative distribution function $F(\varepsilon)$ and may reflect how many firms in the market have been successful in reducing their costs, or some exogenous technological or demand shocks. Its realization is publicly observable at date $t = 2$, i.e. after the manager has chosen his effort level and before the owner decides on liquidation of the firm. The reduced-form profit function $\pi(c, \phi, \varepsilon)$ is continuously differentiable in ϕ and is assumed to have the following properties.

$$\pi(c^L, \phi, \varepsilon) > \pi(c^H, \phi, \varepsilon) \quad \forall \phi \in \Phi, \varepsilon \in R \tag{2}$$

$$\pi(c^L, \phi, \varepsilon) \geq 0 \quad \forall \phi \in \Phi, \varepsilon \in R \tag{3}$$

$$\frac{\partial \pi(c^i, \phi, \varepsilon)}{\partial \phi} < 0 \quad \forall j \in \{L, H\}, \varepsilon \in R \tag{4}$$

Equation (2) says that if the manager is successful in reducing the costs, the firm's profit increases. Equation (3) states that profits are always non-negative in case the manager was successful, independently of the degree of competition. Finally, equation (4) defines the meaning of more competition, i.e., when competition increases, the profits decrease.

Given this structure of the game and the profit function (1) with properties (2)-(4), we now can describe the payoff functions for the owner and the manager and derive the owner's optimization problem.

The payoff of the firm owner U^p is given by

$$U^p = \max\{0, \pi(c, \phi, \varepsilon) - w\} \tag{5}$$

where w is the wage payment to the manager. Given that the owner is risk neutral, he can always close down the firm and realize a payoff of zero.
The manager's payoff is given by

$$U^m = \begin{cases} w - G(p) \text{ if the firm stays in the market} \\ w - G(p) - L^m \text{ if the firm is liquidated} \end{cases} \tag{6}$$

L^m represents the utility loss of the manager in case the firm is liquidated. It may represent the search costs to look for a new job, the loss of human capital or a negative reputation effect which lowers his future income.

Given that the manager's effort is not observable, it cannot be contracted on. By the revelation principle, we can restrict our attention to contracts of the form $\{w^L, w^H\}$, where w^j is the wage payment to the manager if the cost realization of his firm is $c^j, j \in \{L, H\}$. With Π^j denoting the expected gross profit of the firm,[6] the principal's optimization problem at date $t = 0$ is as follows:

$$\max_{\{p, w^L, w^H\}} p[\Pi^L - w^L] + (1 - p)[\Pi^H - w^H] \tag{7}$$

subject to

$$p \in \arg\max_{p' \in [0,1]} p' w^L + (1 - p') w^H - G(p') - (1 - p') l L^m \tag{8}$$

$$p w^L + (1 - p) w^H - G(p) - (1 - p) l L^m \geq \underline{U}^m \tag{9}$$

$$w^j \geq 0, \quad j \in \{L, H\} \tag{10}$$

(8) represents the incentive compatibility constraint, with $l(\phi)$ denoting the probability the manager assigns at date $t = 1$ to the event that his firm will be liquidated at $t = 2$

[6] The expected gross profit of the firm for a given level of intensity of competition ϕ and the realization of the cost parameter c^j is given by:
$\Pi^j(\phi) = \int_\varepsilon \max\{0, \pi(c^j, \phi, \varepsilon)\} dF(\varepsilon), \quad j \in \{L, H\}$

(conditional on the cost parameter being c^j). The incentive compatibility constraint (8) guarantees that it is optimal for the manager to choose $p' = p$. We assume that the principal wants to implement a positive p; otherwise, he did not have to hire a manager in the first place. Accordingly, the manager's payoff is strictly concave in p for any $\{w^L, w^H\}$. If the effort choice problem has an interior solution, constraint (8) can be replaced by the first order condition (11), i.e.,

$$w^L - w^H + lL^m - G'(p) = 0 \tag{11}$$

The participation constraint (9) makes sure that the manager's expected utility from working for the company is at least as high as his outside option given by $\underline{U}^m \geq 0$. The wealth constraint (10) states that the payment to the manager has to be non-negative in both states of the world. It rules out, for instance, that the firm can be sold to the manager.

The following assumption, which is imposed by $G'''(p) \geq 0$, guarantees that the principal's optimization problem is globally concave and has a unique solution:

$$2G''(p) + pG'''(p) > 0, \quad \forall p \in [0,1] \tag{12}$$

In addition, it is assumed that the manager cannot pay for the company ex post in neither state of the world. Despite the wealth constraint, he could do so if Π^Hwere larger than the expected surplus generated by the first best level of effort p^{FB}. In this case it would be optimal to sell the company to the manager for a lump-sum payment amounting to the expected social surplus generated by the first best solution p^{FB} : (13) guarantees that the manager's cost to work for the firm and to choose p^{FB} is smaller than the expected increase in profits, i.e.,

$$\underline{U}^m + G(p^{FB}) + (1 - p^{FB})lL^m < p^{FB}(\Pi^L - \Pi^H) \tag{13}$$

2.2 The optimal contract

Schmidt (1997) shows in proposition 1 of his paper[7] that the unique optimal contract solving the second-best problem implements $p^{SB} = \max\{p^*, \underline{p}\}$, where p^{SB} is charac-

[7]We do not give any proof since it can be found in Schmidt (1997).

terized by

$$G'(p^*) + p^* G''(p^*) = \Pi^L - \Pi^H + lL^m \tag{14}$$

$$\underline{p} G'(\underline{p}) - G(\underline{p}) = lL^m + \underline{U}^m \tag{15}$$

(14) denotes the case when the participation constraint (9) is not binding ($p^* > \underline{p}$), and (15) the case where it is binding ($p^* < \underline{p}$). The optimal compensation scheme is then given by

$$w^L = G'(p^{SB}(\phi)) - l(\phi)L^m \tag{16}$$

$$w^H = 0 \tag{17}$$

It can be shown that $p^{SB} = \max\{p^*, \underline{p}\} < p^{FB}$.

The wage in the high costs state has to be zero to guarantee that the wealth constraint (10) is binding. If it were not binding, i.e., $w^H > 0$, the solution to the second best problem should be the same as for the relaxed problem without (10). By (13), however, the solution to the relaxed problem is selling the company to the manager, i.e., $w^H < 0$, so (10) is violated, which is a contradiction. The expression for w^L then follows directly from the incentive compatibility constraint (11).

In what follows, we measure the strength of incentives by the difference between the two wage levels ($w^L - w^H$).

2.3 The effects of competition on the strength of incentives

Based on Schmidt's (1997) model, we now derive the effect of an increase in competition on the manager's strength of incentives. Specifically, we are interested in the sign of (18):

$$\frac{\partial(w^L - w^H)}{\partial \phi} = G''(p^{SB}(\phi)) \frac{dp^{SB}(\phi)}{d\phi} - \frac{dl(\phi)}{d\phi} L^m \tag{18}$$

First, we need to understand how competition affects the manager's effort level, i.e., $\frac{dp^{SB}(\phi)}{d\phi}$. There are two effects which play a role, one which Schmidt (1997) calls

"threat of liquidation effect" (working through $\frac{dl(\phi)}{d\phi}L^m$), and another, which he calls the "value-of-a-cost reduction effect" (working through $[\partial\Pi^L(\phi)/\partial\phi - \partial\Pi^H(\phi)/\partial\phi]$).

Let us first describe the threat of liquidation effect. Given assumption (2), an increase in the degree of competition reduces the profit in both states of the world. Therefore, it increases the probability that the firm will be liquidated in the high cost situation, i.e. $\frac{dl(\phi)}{d\phi} \geq 0$, which would cause the manager a utility loss of L^m. This increased probability of a utility loss (turnover costs etc.) gives the manager a direct incentive to work harder. Also, by threat of liquidation, the owner's cost to implement a higher level of effort may decrease as competition becomes more intense. The threat-of-liquidation effect thus captures the common presumption that the manager works harder if competition becomes more intense.

The second effect which has to be taken into account is the value-of-a-cost reduction effect. From (14) we know that the optimal effort level p^* trades off the marginal increase of total surplus given by $(\Pi^L - \Pi^H + lL^m - G'(p))$ against the higher marginal rent the firm owner has to pay to his manager, which is equal to $(pG''(p))$. The value-of-a-cost reduction effect to the principal is given by $(\Pi^L - \Pi^H)$. Given that an increase in ϕ reduces both Π^L and Π^H, the sign of $[\partial\Pi^L(\phi)/\partial\phi - \partial\Pi^H(\phi)/\partial\phi]$ is ambiguous. In case an increase in the intensity of competition erodes the value of a cost reduction to the principal, i.e.,

$$\frac{\partial\Pi^L}{\partial\phi} - \frac{\Pi^H}{\partial\phi} < 0 \tag{19}$$

then the principal is less likely to offer a high rent to the manager, and he may want to switch to a low-powered incentive scheme. In this case, an increase in competition induces the manager to work less.

As Schmidt shows in Proposition 3 of his paper, the effect of a marginal increase in competition on the manager's optimal effort level is given by

$$\frac{dp^*}{d\phi} = \frac{[\partial\Pi^L(\phi)/\partial\phi - \partial\Pi^H(\phi)/\partial\phi] + (dl(\phi)/d\phi)L^m}{2G''(p^*) + p^*G'''(p^*)} \tag{20}$$

if (9) is not binding, and by

$$\frac{d\underline{p}}{d\phi} = \frac{(dl(\phi)/d\phi)L^m}{\underline{p}G''(\underline{p})} \tag{21}$$

if (9) is binding.

After having understood how competition affects the manager's effort level, we can now go back to (18) and rewrite it as follows: In case (9) is not binding, the effect of competition on the strength of incentives is given by (22).

$$\frac{\partial(w^L - w^H)}{\partial\phi} = \frac{G''(p^*)[\partial\Pi^L(\phi)/\partial\phi - \partial\Pi^H(\phi)/\partial\phi]}{2G''(p^*) + p^*G'''(p^*)} + \frac{dl(\phi)}{d\phi}L^m\left[\frac{G''(p^*)}{2G''(p^*) + p^*G'''(p^*)} - 1\right] \tag{22}$$

The second part of (22), which now captures the threat of liquidation effect, is always negative since $dl(\phi)/d\phi L^m > 0$ and the term in brackets is negative due to $G''(p^*) > 0, \quad G'''(p^*) > 0$ and $G''(p^*) < [2G''(p^*) + p^*G'''(p^*)]$. The sign of (22) now depends on whether the value-of-a-cost reduction effect $[\partial\Pi^L(\phi)/\partial\phi - \partial\Pi^H(\phi)/\partial\phi]$ is positive or negative and on its relative size to the threat of liquidation effect as given by the second term in (22). In case $[\partial\Pi^L(\phi)/\partial\phi - \partial\Pi^H(\phi)/\partial\phi] > 0$,we cannot determine the sign of (22) since both terms go in opposite directions. If $[\partial\Pi^L(\phi)/\partial\phi - \partial\Pi^H(\phi)/\partial\phi] < 0$, however, (22) is negative, i.e., an increase in the intensity of competition always lowers the strength of incentives.

In case (9) is binding, (18) can be replaced by (23), and the effect of competition on the strength of incentives is just related to the threat of liquidation effect and as follows:

$$\frac{\partial(w^L - w^H)}{\partial\phi} = \frac{dl(\phi)}{d\phi}L^m\left[\frac{1}{\underline{p}} - 1\right] \tag{23}$$

Equation (23) is greater or equal to zero since $dl(\phi)/d\phi L^m > 0$ and $[1/\underline{p} - 1] \geq 0$ due to $0 \leq \underline{p} \leq 1$. In other words, more intense competition leads to stronger incentives for managers.

Intuitively, these results can be explained as follows: stronger competition induces the manager to work harder due to the higher threat of liquidation and the associ-

ated turnover costs (as follows from the incentive compatibility constraint (8)). If his bargaining power is strong (good outside options, participation constraint binding), he can afford to demand a higher compensation for his increased effort level. On the other hand, if the manager's bargaining power is weak (participation constraint not binding), the owner can profit from the fact that the manager has an (intrinsic) incentive to work harder and can therefore reduce the incentives. As such, an increase in competition decreases incentives in this case - unless the value of an innovation increases strongly with competition.[8]

2.4 Summary and testable hypothesis

We can resume the effects of an increase in the intensity of competition on the manager's effort level and on the strength of incentives by the following table:

Table 1: Summary of effects of an increase in the intensity of competition

	effect on p^{SB}		effect on $(w^L - w^H)$		total effect on $(w^L - w^H)$
	threat of liq. effect	val.-of-cost red. effect	threat of liq. effect	val.-of-cost red. effect	
(PC) not binding and $[\frac{\partial \Pi^L}{\partial \phi} - \frac{\partial \Pi^H}{\partial \phi}] > 0$	$\nearrow p$	$\nearrow p$	$\searrow (w^L - w^H)$	$\nearrow (w^L - w^H)$	?
(PC) not binding and $[\frac{\partial \Pi^L}{\partial \phi} - \frac{\partial \Pi^H}{\partial \phi}] < 0$	$\nearrow p$	$\searrow p$	$\searrow (w^L - w^H)$	$\searrow (w^L - w^H)$	$\searrow (w^L - w^H)$
(PC) binding	$\nearrow p$	-	$\nearrow (w^L - w^H)$	-	$\nearrow (w^L - w^H)$

Since we cannot observe the effort level of the manager, we draw our attention to the strength of incentives in order to derive a testable hypothesis from the model. In case the participation constraint (9) is not binding, we do not know whether more

[8]Then, the owner has again an incentive to induce the manager to work harder by a higher compensation in the case of success.

competition leads to stronger or weaker incentives. It depends on the sign of the value-of-a-cost reduction effect. In contrast, the model predicts an increase in the strength of incentives ($w^L - w^H$) if (9) is binding (for an intuitive explanation of these effects, see Section 2.3, last paragraph).

To empirically discriminate between these two situations, we can interpret the meaning of the participation constraint as follows. If the participation constraint (9) is binding, the manager is just indifferent between his job and his outside option utility. Therefore, he is in a situation of strong bargaining power. In the case where the participation constraint is not binding, however, the manager gets an expected rent in excess of his reservation utility. It is likely that there is an excess supply of managers and that the manager's bargaining power is weak(er). Let us now formulate this hypothesis as follows:

Hypothesis 1 *If managers have good outside options (compared to when they have bad outside options), an increase in the intensity of competition leads to stronger incentive schemes for the manager and a higher compensation.*[9]

Or, in mathematical terms: $\frac{\partial(w^L - w^H)}{\partial \phi}$ *(pc binding)* $\geq$ $\frac{\partial(w^L - w^H)}{\partial \phi}$ *(pc not binding)*[10]

3 Measuring the intensity of Competition

Since we would like to empirically explore the relationship between product market competition and executive compensation, we need an indicator for the degree of competition in an industry.

[9] Since $w^H = 0$ in the optimal contract, an increase in $w^L - w^H$ not only signifies an increase in the relative, but also the absolute salary.

[10] As can be seen from Table 1 (or equations (22) and (23)), Hypothesis 1 always holds if $[\partial \Pi^L(\phi)/\partial \phi - \partial \Pi^H(\phi)/\partial \phi] \leq 0$, but does not necessarily hold if the value-of-cost reduction effect is positive ($[\partial \Pi^L(\phi)/\partial \phi - \partial \Pi^H(\phi)/\partial \phi] > 0$) and very large compared to the threat-of-liquidation effect. However, as Schmidt (1997: 201) mentions, there are good reasons to believe that $[\partial \Pi^L(\phi)/\partial \phi - \partial \Pi^H(\phi)/\partial \phi] \leq 0$ holds, especially if competition is intense. In this case, the owner can always liquidate the firm if expected profits are negative. This sets a lower bound for his profits if costs are high which is not relevant in the low cost state. Furthermore, empirical studies suggest an inverted U-shaped relationship between competition and the incentive to innovate; while the incentive to innovate increases, when the market changes from monopoly to an oligopoly, it decreases again as soon as more competitors enter the market and the market share declines (see Schmidt, 1997: 201). As such, Hypothesis 1 is very plausible for markets with a minimal (initial) level of competition.

3.1 The Boone-Weigand indicator

There exists a large empirical literature on measuring the intensity of competition in an industry. Common measures of competition include the concentration ratio of an industry, industry profits, price-cost margins or import penetration. As Boone and Weigand (2000) outline, these concentration measures only capture the notion of increased competition if competition is intensified through a reduction of entry costs. However, if competition increases as a result of more aggressive interaction between firms, more competition can be consistent with increases as well as decreases of these traditional measures.[11]

Boone and Weigand (2000) propose a competition indicator which is based on relative profits[12] and which overcomes the ambiguity problem of the traditional competition measures. The basic idea is to relate efficiency differences between firms to profit differences. The more competitive an industry is, the more it raises the profits of an efficient firm relative to the profit of a less efficient firm. As such, higher competition (as implied by many models, see Boone and Weigand (2000)) goes together with higher relative profits.[13]

The Boone-Weigand (BW) indicator always moves in the same direction as "competition" itself. It captures the notion of a higher competition going together with more firms in the market, but it also encompasses the case of increased competition resulting from a more aggressive behavior of the firms in the industry. The relation between the relative profits of firm i to its relative costs can be represented as follows, i.e.,

$$\frac{\pi_{it}}{\bar{\pi}_t} = a + b\frac{c_{it}}{\bar{c}_t} \tag{24}$$

[11] Consider an industry where firms start to interact more aggressively with each other, because a minimum price is abolished or because shop opening hours are liberalized for instance. It is likely that the least efficient firms have to exit. As a result, we have a higher intensity of competition which results in a higher concentration. As to industry profits, an increase in competition always reduces the profits of the least efficient firms in the market, but it does not necessarily reduce each firm's profit and it can even raise the profits of the most efficient firms. Therefore, more intense competition lowers an industry's average profits only under certain conditions.

[12] Relative profits are defined as the profit of the efficient firm relative to the profit of an inefficient firm.

[13] An increase in competition can go together with higher or lower absolute profits of the efficient firm. The important point to note is that when the profits of the efficient firm increases, the profits of the inefficient firm increases relatively less or decreases; and when the profits of the efficient firm decreases, the profits of the inefficient firm decreases even more.

$$i \;=\; 1, ..., n, \quad t = 1, ..., T$$

where $\pi_{it} = (p_{it} - c_{it})x_{it}$ defines the profit of firm i, excluding possible fixed costs, producing output level x_{it} at marginal cost c_{it} and selling at price p_{it} in period t in a certain market or industry. $\bar{\pi}_t$ and $\bar{c}_t$,which are used to normalize firm i's profits and marginal costs, stand for the profits and the marginal costs of the most efficient firm.

The coefficient b measures the intensity of competition. It is typically negative since firms with higher relative marginal costs have also relatively lower profits.[14] As competition increases, the slope b becomes larger in absolute value, i.e., in a more competitive environment, a given efficiency gain is better rewarded in the sense that relative profits increase more.

A detailed description of the empirical implementation of the Boone-Weigand competition indicator can be found in the appendix. As can be seen therefrom, the goal would be to empirically estimate the b in equation (24) for each (3-digit) sub-industry in the industries 32 and 33. However, the best feasible solution is to estimate the elasticity of relative profits (relative to the industry median) to changes in relative average costs. Again, the more sensitive relative profits react to relative costs, the more competitive an industry is assumed to be.

3.2 Industry price-cost margin

For comparison purposes, we use another year-specific competition measure, which is based on the firms' price-cost margins as defined by (25) and is frequently used as a proxy for the Lerner index.

$$pcm_{it} = \frac{profit_{it}}{sales_{it}} \tag{25}$$

We compute an industry-specific price-cost margin measure $ind3\_pcm_{jt}$, by taking the *median* of the firm-specific price-cost margins pcm_{it} in a given 3-digit sub-industry.

Figure 2 and 3 display the development of competition in industries 32 and 33. As can be seen therefrom, competition measured by the Boone-Weigand-Indicator

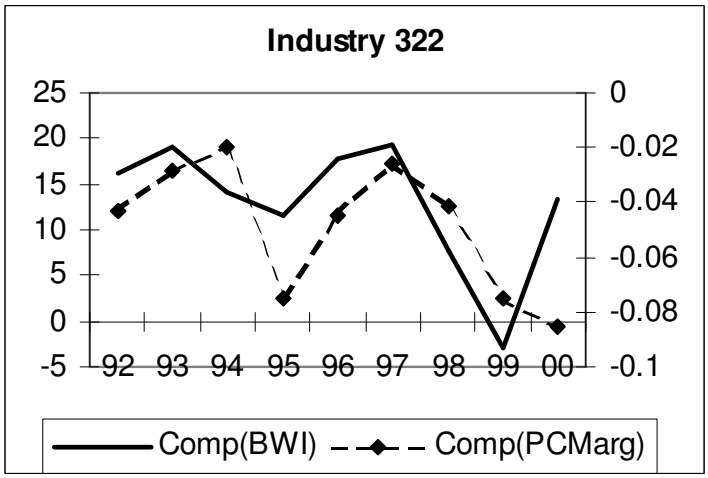
[14]This hypothesis is supported by empirical evidence in Boone and Weigand (2000). It is also consistent with the theoretical models which relate profits of a firm to its efficiency.

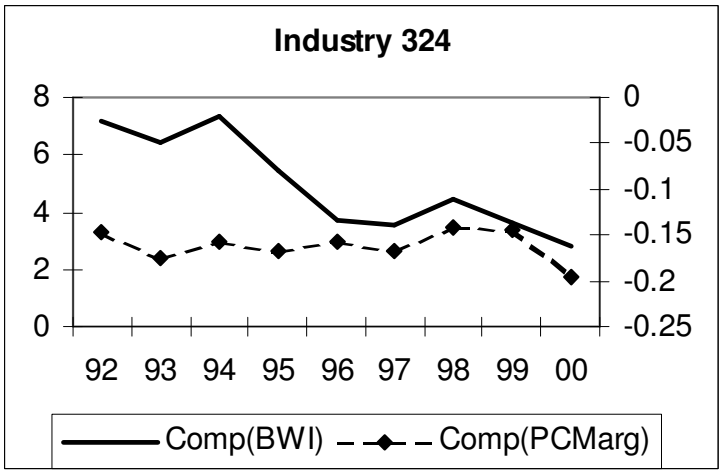
(Comp(BWI)) seems to move in the same direction as competition measured by the Price-Cost-Margin (Comp(PCMarg)).[15] Only for industry 326, we observe a remarkable increase in the intensity of competition from 1992 to 1993 as measured by the BWI, but not as measured by the Price-Cost-Margin. However, an increase in competition from 1992 to 1993 is quite plausible, since the plastic and rubber products manufacturing industry (NAICS 326, see Appendix) is highly dependent on sales to the transport industries (road, air, rail and marine). Due to the first Irak war in 1991 and the subsequent increase in oil prices, more aggressive interactions between the firms might have resulted, which is reflected in the BWI but not necessarily in the Price-Cost-Margin. However, in the empirical part, we will check the robustness of the results with respect to this potential outlier.

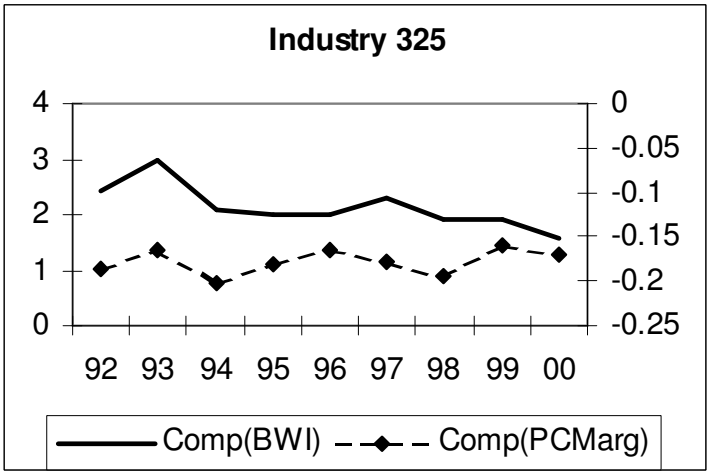
Although the Boone-Weigand-Indicator is theoretically superior to the Price-Cost-Margin since it better captures the interaction between the firms, we have to bear in mind that it has to be empirically estimated with imperfect data (proxies for marginal costs etc.) We address this problem in the empirical part as follows: In a first set of estimations, we employ the Boone-Weigand-Indicator as a measure of competition. In a second set, we model competition as a latent variable, with two indicators (Boone-Weigand-Indicator, PC-Margin) thereof. Since the first principal component explains roughly 80 percent of the variation of the X-Matrix (BWI, PCMarg) for both industries (83 % in industry 32 and 79 % in industry 33), it seems to be a reasonable approximation for the unobservable intensity of competition.

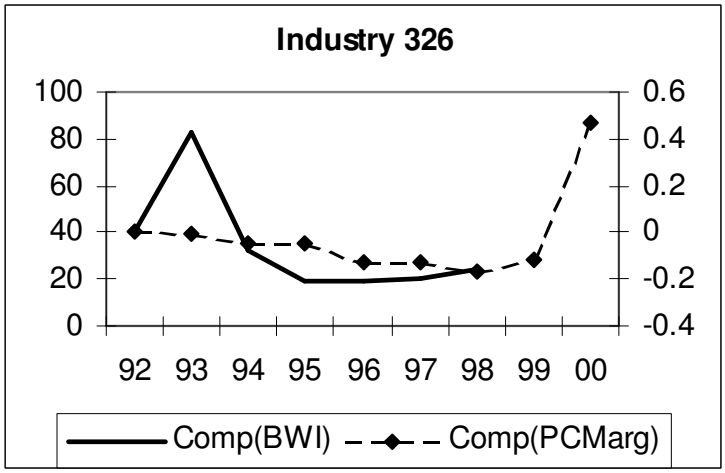
[15]Since a higher estimated Boone-Weigand-Indicator and a higher Price-Cost-Margin reflect less competition, we took the negative amount of these measures in order to get competition-indicators, which increase in the intensity of competition.

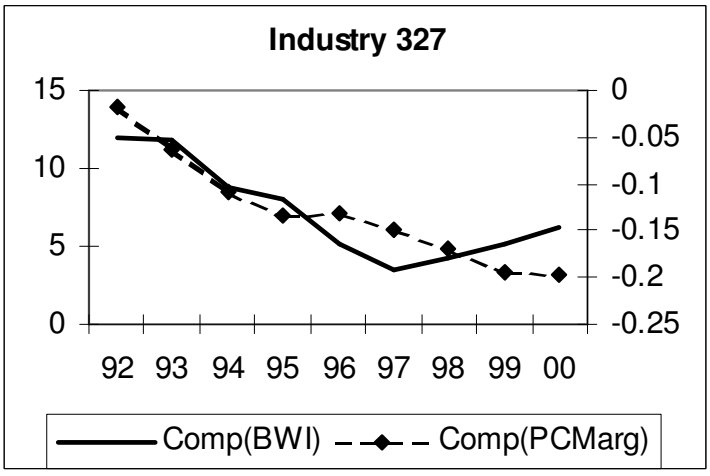
Figure 2: Competition in Industry 32





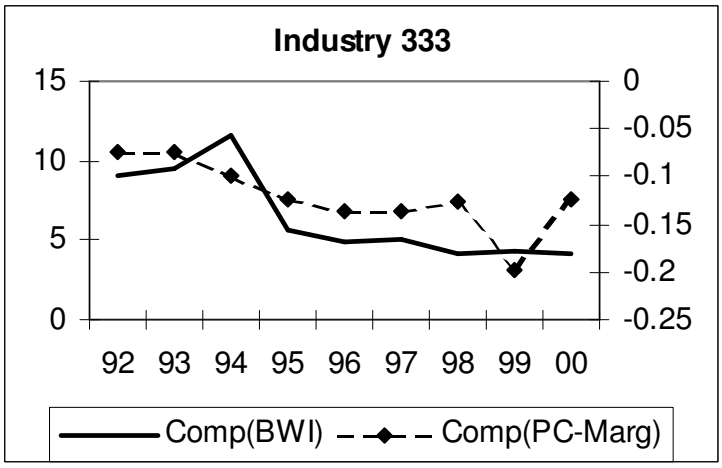


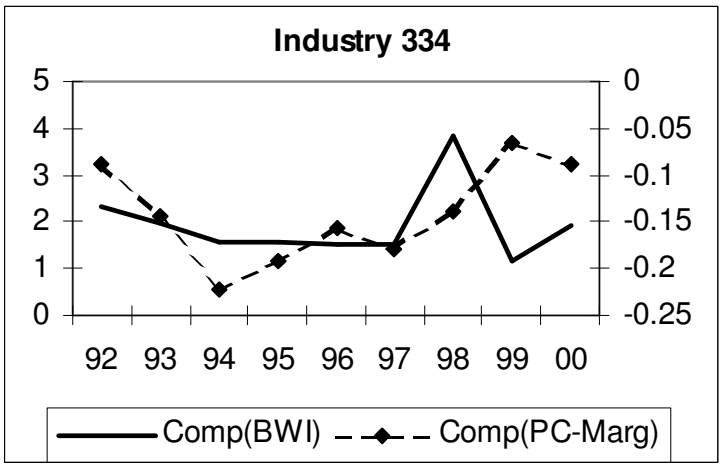


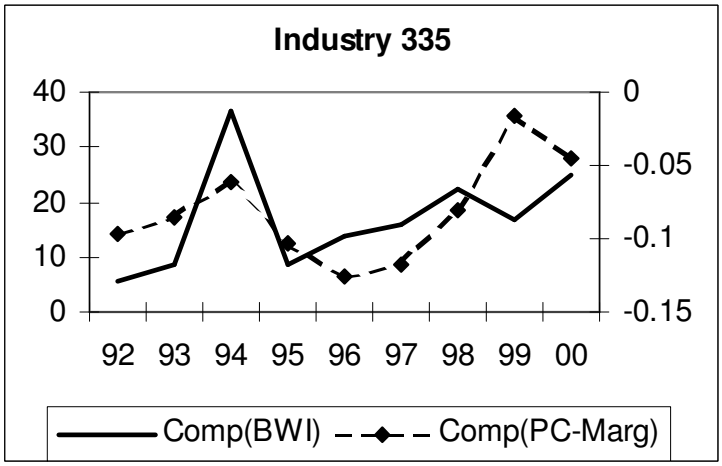


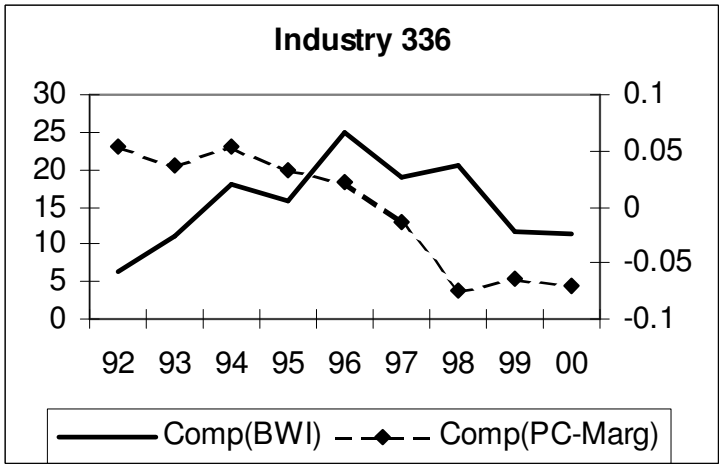
Notes:
1) The left vertical axis measures the intensity of competition as implied by the BWI and the right axis as implied by the PCMargin. Higher values reflect an increasing intensity of competition.
2) From the 7 3-digit subindustries in Industry 32 (321, 322, 323, 324, 325, 326, 327), there are 5 subindustries (322, 324, 325, 326, 327) with enough data for estimating the Boone-Weigand-Indicator (i.e.> 30 observations, see Appendix).

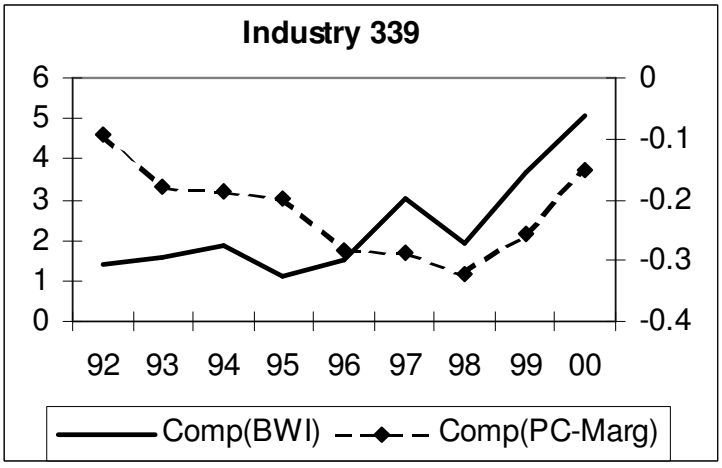
Figure 3: Competition in Industry 33











Notes:
1) The left vertical axis measures the intensity of competition as implied by the BWI and the right axis as implied by the PCMargin. Higher values reflect an increasing intensity of competition.
2) From the 8 3-digit subindustries in Industry 33 (331, 332, 333, 334, 335, 336, 337, 338), there are 5 subindustries (333, 334, 335, 336, 339) with enough data for estimating the Boone-Weigand-Indicator (i.e.> 30 observations, see Appendix).

4 The Econometric Models

In the following, we will estimate two different models. While model 1 focuses on the relationship between competition and executive compensation, model 2 captures the *interaction* between competition and the manager's outside options in relation to executive compensation.

4.1 Model 1: Relationship between Competition and Executive Compensation

The basic panel-data model to be estimated is the following:

$$Exe_{it} = \alpha_j + \gamma_t + b \cdot Comp_{jt} + c \cdot Sales_{it} + d \cdot \Delta ShareholderValue_{it} + e \cdot Uncert_{it} + f \cdot DJg_t + \epsilon_{it} \tag{26}$$

where i denotes the firm, j the (3-digit-level) industry, firm i is in, and t stands for the specific year (recall that we have panel data from 1992 to 2000).

Exe refers to firm i's executive compensation measures. We build five measures to describe the level and structure of executive compensation:

1. The **fixed level** of compensation: $salary_{it}$ stands for the fixed salary, the CEO receives.

2. The **variable level** of compensation: $salaryv_{it}$ denotes the variable part of the total compensation, which includes bonus, the total value of restricted stock granted, total value of stock options granted (using B-S formula), long-term incentive payouts, and all other total.

3. **Relative compensation**: In order to get an idea about the relationship between fixed and variable compensation, we build a variable called relative compensation, which is defined as:

$$salaryrel_{it} = \frac{salaryv_{it}}{salary_{it}} \tag{27}$$

4. **Stock options** granted relative to total compensation ($optpc_{it}$): An indicator, which measures more directly the strength of CEO *incentives* is the value of stock

option grants per total compensation ($salary_{it}+salayv_{it}$). If a CEO is exclusively paid by options, then the measure takes a value of 1, whereas the absence of stock option grants generates a value of 0.

Precisely,

$$optpc_{it} = \frac{blk\_value_{it}}{salary_{it} + salaryv_{it}} \tag{28}$$

where blk_value_{it} is the value of stock option grants to the CEO.[16]

5. **CEO ownership** of firm ($shrownpc_{it}$): Letting executives own part of the firm is another way to align their interests with those of the owners. We measure CEO firm ownership by the percentage of the company's shares owned by the CEO, i.e.

$$shrownpc_{it} = \frac{shares\ \ owned\ \ by\ \ CEO_{it}}{total\ \ number\ \ of\ \ shares_{it}} * 100 \tag{29}$$

By taking these different measures of compensation, we are not only able to derive the effect of competition on total compensation, but also to investigate how a changing degree of competition affects the structure of compensation (fix versus variable compensation, use of incentive schemes etc.)

As for a measure of the degree of competition ($Comp$), we shall employ two indicators (see Section 3): the Boone-Weigand indicator and a latent variable indicator.[17]

In order to control for firm-specific characteristics, we further include sales (approximating the size of the firm, see Baker and Hall (1998))[18], the change in shareholder

[16]The value is calculated using the Black Scholes formula.

[17]As described in Section 3.2, we employ the first principal component of the Matrix (BW-indicator, Price-Cost-Margin). If a factor analysis is conducted instead of a principal component analysis (which requires an estimate for the communalities), the difference between the first principal component and the score of the factors is mainly in the level; the correlation between the two is very high, or even 1 if the communalities are estimated using the squared multiple correlations between the two variables (which is a standard routine in STATA).

[18]For instance, the size of the firm might influence ownership concentration *shrownpc*. When a firm grows, managers are likely to have a lower share due to wealth constraints and efficient risk bearing, see Demsetz and Lehn (1985).

value[19] and uncertainty of the economic environment[20]. Since executive compensation might be driven by the development of the stock market, we include the growth rate of the Dow-Jones-Index (DJg) as a further control. Next to the control variables, we include industry-fixed effects as well as time-fixed effects. However, we will later check the robustness of the results if firm-specific fixed effects are included instead of industry-fixed-effects.

Of course, our main interest lies on the coefficient b, which describes the relationship between the degree of competition in industry j and executive compensation of firms i in industry j.

4.2 Model 2: Relationship between Competition, Outside Options Manager and Executive Compensation

Model 2 differs from Model 1 in that we include an interaction term $Comp \cdot OP$ (Competition·Outside Options) instead of $Comp$. The idea is to test the hypothesis (see Section 2) that with good outside options of the managers, an increase in competition is more likely to lead to an increase in incentives/compensation than with bad outside options. We employ two measures for the outside options of the manger. First, we think that the growth rate of the Dow Jones (denoted by DJg) might reflect a CEO's outside options reasonably well. The better the economy is going and the better the expectations are about future growth, the easier it is for managers to find another (good) job and therefore, the higher the outside options generally are. Secondly, we employ an indicator which is more tightly related to a CEO's past performance (denoted by BP (=bargaining power)). The following dummy variable is used for that purpose: a value of 1 (strong bargaining power) is assigned, if the CEO's firm had an average growth rate of shareholder return, which exceeded the industry's median over the past three years; otherwise a value of zero is assigned (weak bargaining power).

[19] As is standard in the literature on the relationship between pay and performance, we measure firm performance by the the change in shareholder value, which is defined as the return on equity multiplied by the market value of equity in the previous period (see e.g. Jensen and Murphy, 1990).

[20] The uncertainty of the economic environment is measured by the standard deviation of the stock price over the latest 60 months. It is the volatility figure which is used in calculating the Black-Scholes values for options. The idea is that with higher uncertainty, it becomes more difficult to monitor the management, and incentive alignments may be more likely achieved through high CEO ownership than through cash compensation (see Demsetz and Lehn, 1985).

Model 2 is given by equation (30):

$$Exe_{it} = \alpha_j + \gamma_t + b \cdot Comp_{jt} \cdot OP_{it} + c \cdot Sales_{it} + d \cdot \Delta ShareholderValue_{it} + e \cdot Uncert_{it} + f \cdot DJg_t + \epsilon_{it} \tag{30}$$

Except from the interaction term, Model 2 employs the same variables as Model 1. We expect b to take a positive sign since an increase in competition is more likely to result in higher compensation/incentives if the manager's outside options are good rather than bad.[21]

5 Results

We estimate equations (26) and (30) using OLS. Although the intensity of competition might depend on on the way, executives are compensated, we do not think that endogeneity poses a problem in our application. First of all, the four-firm concentration ratios in the considered industries are rather low (except for industry 336, see www.census.gov). Therefore, strategic interaction between firms, where compensation contracts are used to affect competition, is unlikely. Secondly, our regressions yield very similar results when using the one-year lagged (and hence exogenous) competition indicator instead of the simultaneous one (see the Section with the robustness tests).

5.1 Results for Model 1

Tables 1 and 2 depict the estimation results for industry 32. Whereas table 1 relies on the BW-indicator as a measure of competition, table 2 uses the latent variable (LV) approach. Since we look at five sub-industries, we include 5 industry-fixed effects next to the time-fixed effects (the year 1992 is dropped in order to avoid perfect collinearity).

As can be seen from table 1, an increase in competition led to a decrease in executive compensation, in absolute terms (salary) as well as in incentives (variable salary, option share). Therefore, for industry 32, we find a *negative* relationship between competition and the use of incentives.

[21] The competition indicator is constructed in a way which assigns higher values to more intense competition, see Section 3.

Table 2 confirms these findings. Modelling competition as a latent variable doesn't alter the previous result after which an increase in competition lead to a decrease in compensation as well as the use of incentive schemes.

As for the control variables, they turn out to be mostly significant and of the expected sign. Compensation typically increases with the size of the firm, the growth in shareholder return ("pay-for-performance"), the uncertainty of the firm's environment and the growth of the Dow Jones Index. As can be seen from the last column tables 1 and 2, equities and options are used in a substitutive way.[22] The more options are given to the CEO, the less equities are needed for aligning the interests of the CEO with those of the firm.

Table 1: Results for Industry 32, BW-Indicator

	Ind. 32 Salary	Ind.32 Salaryv	Ind.32 Salaryrel	Ind. 32 Optpc	Ind. 32 Shrownpc
Competition measured by BWI	**-0.005**** **(0.002)**	**-0.008**$^{(*)}$ **(0.005)**	**-0.003 (0.005)**	**-0.218**** **(0.089)**	**0.033 (0.084)**
Sales	0.168*** (0.018)	0.392*** (0.047)	0.223*** (0.039)	1.601** (0.675)	0.624 (0.468)
ΔShareholder Value	0.085*** (0.024)	0.272*** (0.069)	0.188*** (0.054)	3.382*** (1.071)	-1.430 (1.932)
Uncertainty	0.137* (0.071)	0.664*** (0.248)	0.521** (0.226)	16.345*** (3.513)	1.494 (1.861)
DJ-growth	0.014*** (0.003)	0.047*** (0.009)	0.033*** (0.009)	0.414** (0.167)	-0.074 (0.063)
Optpc	-	-	-	-	-0.060*** (0.016)
Industry-FE	Yes	Yes	Yes	Yes	Yes
Year-FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.99	0.96	0.34	0.71	0.38
Number of Observations	1326	1314	1312	1323	471

Note: Salary, Salaryv, Salaryrel, Sales and Uncertainty are in logs. Coefficients that are significantly different from zero at the 1%, 5%, 10%, and 15% level are marked with ***, **, *, and $^{(*)}$ respectively. White standard errors accounting for serial correlation within firms are depicted in parantheses.

[22] We do not include the variable shrownpc in the estimation equation optpc because it would cause a large drop in the available number of observations.

Table 2: Results for Industry 32, LV-Indicator

	Ind. 32 Salary	Ind.32 Salaryv	Ind.32 Salaryrel	Ind. 32 Optpc	Ind. 32 Shrownpc
Competition as a latent variable	**-0.050**** **(0.020)**	**-0.100*** **(0.056)**	**-0.051 (0.050)**	**-2.313**** **(0.962)**	**0.021 (0.763)**
Sales	0.169*** (0.018)	0.393*** (0.047)	0.224*** (0.039)	1.619** (0.675)	0.633 (0.470)
ΔShareholder Value	0.086*** (0.024)	0.274*** (0.069)	0.189*** (0.054)	3.405*** (1.074)	-1.461 (1.934)
Uncertainty	0.140* (0.071)	0.672*** (0.249)	0.527** (0.227)	16.490*** (3.518)	1.536 (1.866)
DJ-growth	0.013*** (0.003)	0.046*** (0.010)	0.033*** (0.009)	0.398** (0.168)	-0.078 (0.064)
Optpc	-	-	-	-	-0.060*** (0.016)
Industry-FE	Yes	Yes	Yes	Yes	Yes
Year-FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.99	0.96	0.34	0.71	0.38
Number of Observations	1326	1314	1312	1323	471

Note: Salary, Salaryv, Salaryrel, Sales and Uncertainty are in logs. Coefficients that are significantly different from zero at the 1%, 5%, 10%, and 15% level are marked with ***, **, *, and $^{(*)}$ respectively. White standard errors accounting for serial correlation within firms are depicted in parantheses.

Tables 3 and 4 depict the relationship between competition and compensation for industry 33. In contrast to industry 32, where more competition led to lower compensation/incentive schemes, the opposite turns out to be true for industry 33. An increase in competition led to an increase in variable compensation (salaryv), although only significantly in the latent variable approach.

At any rate, it is striking that the sign of the competition measure is exactly the opposite in industries 32 and 33 for four out of five compensation indicators. As such, the theoretical models which predict ambiguous effects of competition on compensation seem to be supported by the data.

Table 3: Results for Industry 33, BW-Indicator

	Ind. 33 Salary	Ind.33 Salaryv	Ind.33 Salaryrel	Ind. 33 Optpc	Ind. 33 Shrownpc
Competition measured by BWI	**0.002** **(0.003)**	**0.008** **(0.006)**	**0.005** **(0.007)**	**0.146** **(0.156)**	**0.097** **(0.073)**
Sales	0.197*** (0.031)	0.505*** (0.036)	0.290*** (0.038)	2.619*** (0.644)	-0.871* (0.477)
ΔShareholder Value	-0.080(*) (0.052)	0.117 (0.117)	0.223* (0.119)	2.572 (2.368)	4.739*** (0.638)
Uncertainty	-0.117(*) (0.074)	0.329** (0.151)	0.421*** (0.146)	18.133*** (2.859)	1.796 (1.759)
DJ-growth	0.010*** (0.003)	0.050*** (0.008)	0.040*** (0.008)	0.714*** (0.158)	0.032 (0.070)
Optpc	-	-	-	-	-0.101*** (0.018)
Industry-FE	Yes	Yes	Yes	Yes	Yes
Year-FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.98	0.96	0.36	0.69	0.39
Number of Observations	2425	2399	2392	2420	1240

Note: Salary, Salaryv, Salaryrel, Sales and Uncertainty are in logs. Coefficients that are significantly different from zero at the 1%, 5%, 10%, and 15% level are marked with ***, **, *, and (*) respectively. White standard errors accounting for serial correlation within firms are depicted in parantheses.

Table 4: Results for Industry 33, LV-Indicator

	Ind. 33 Salary	Ind.33 Salaryv	Ind.33 Salaryrel	Ind. 33 Optpc	Ind. 33 Shrownpc
Competition as a latent variable	**0.006**	**0.088****	**0.069**$^{(*)}$	**1.093**	**0.510**
	(0.035)	**(0.040)**	**(0.047)**	**(0.895)**	**(0.473)**
Sales	0.197***	0.504***	0.290***	2.613***	-0.872*
	(0.031)	(0.036)	(0.038)	(0.644)	(0.479)
ΔShareholder Value	-0.080$^{(*)}$	0.116	0.222*	2.564	4.726***
	(0.052)	(0.117)	(0.118)	(2.358)	(0.647)
Uncertainty	-0.118$^{(*)}$	0.323**	0.416***	18.043***	1.734
	(0.073)	(0.151)	(0.146)	(2.859)	(1.756)
DJ-growth	0.010***	0.054***	0.043***	0.770***	0.064
	(0.003)	(0.008)	(0.008)	(0.158)	(0.074)
Optpc	-	-	-	-	-0.101***
					(0.018)
Industry-FE	Yes	Yes	Yes	Yes	Yes
Year-FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.98	0.96	0.36	0.69	0.39
Number of Observations	2425	2399	2392	2420	1240

Note: Salary, Salaryv, Salaryrel, Sales and Uncertainty are in logs. Coefficients that are significantly different from zero at the 1%, 5%, 10%, and 15% level are marked with ***, **, *, and $^{(*)}$ respectively. White standard errors accounting for serial correlation within firms are depicted in parantheses.

5.2 Robustness Tests for Model 1

Before drawing any definite conclusions, we would like to see how robust our results are with respect to the chosen econometric specification as well as the timing between changes in competition and executive compensation.

As for the first, we re-estimate model 1 using firm-fixed-effects instead of industry-fixed effects. Although inclusion of firm-fixed effects makes sense from a conceptual point of view, the estimation of 242 (industry 32) or 613 (industry 33) additional parameters poses an econometric problem in terms of lost degrees of freedom as well as small remaining variation in the competition indicator.[23] Nevertheless, it seems

[23]In fact, inclusion of firm- and time-fixed effects captures a large part of the variance of the

important to check at least whether the signs remain the same as soon as firm-fixed effects are included instead of industry-fixed effects.

Secondly, it might be the case that firm-owners do not immediately adapt executive compensation to changes in competition, but rather with a lag. Therefore, we re-estimate model 1 including the 1-year-lagged competition indicators instead of the contemporaneous competition indicators.

As can be seen from tables 5 and 6, the results are fairly robust with respect to these changes. Alternative specifications mostly affect the significance, but not the sign of the estimated coefficients.

Table 5: Robustness Tests, Industry 32

	Salary	Salaryv	Salaryrel	Optpc	Shrownpc
Competition measured by BWI Ind. 32 Firm-FE: yes	**-0.001** **(0.001)**	**-0.006** **(0.005)**	**-0.005** **(0.005)**	**-0.13*** **(0.07)**	**0.08** **(0.07)**
Competition measured by BWI Ind. 32 Competition: 1 Lag	**-0.003*** **(0.002)**	**-0.008**$^{(*)}$ **(0.005)**	**-0.005** **(0.005)**	**-0.22*** **(0.11)**	**-0.04** **(0.05)**
Competition measured by LV Ind. 32 Firm-FE: yes	**-0.006** **(0.017)**	**-0.078** **(0.054)**	**-0.071** **(0.05)**	**-1.22**$^{(*)}$ **(0.77)**	**0.78** **(0.65)**
Competition measured by LV Ind. 32 Competition: 1 Lag	**-0.044**** **(0.02)**	**-0.08**$^{(*)}$ **(0.06)**	**-0.04** **(0.05)**	**-2.17**** **(1.02)**	**-0.02** **(0.56)**

Coefficients that are significantly different from zero at the 1%, 5%, 10%, and 15% level are marked with ***, **, *, and $^{(*)}$ respectively. White standard errors accounting for serial correlation within firms are depicted in parantheses.

competition indicator. A simple regression of the BW-Indicator on firm- and time-fixed effects shows that 75 percent (industry 32) / 88 percent (industry 33) of the variance of the BW-Indicator can be explained by these fixed effects.

Table 6: Robustness Tests, Industry 33

	Salary	Salaryv	Salaryrel	Optpc	Shrownpc
Competition measured by BWI Ind. 33 Firm-FE: yes	**-0.001** **(0.002)**	**0.005** **(0.006)**	**0.005** **(0.007)**	**0.18** **(0.15)**	**0.01** **(0.03)**
Competition measured by BWI Ind. 33 Competition: 1 Lag	**-0.0006** **(0.004)**	**-0.003** **(0.006)**	**-0.003** **(0.007)**	**-0.16** **(0.14)**	**-0.03** **(0.05)**
Competition measured by LV Ind. 33 Firm-FE: yes	**0.02** **(0.02)**	**0.07*** **(0.04)**	**0.07**$^{(*)}$ **(0.04)**	**1.22** **(0.97)**	**-0.08** **(0.22)**
Competition measured by LV Ind. 33 Competition: 1 Lag	**-0.006** **(0.02)**	**0.07**$^{(*)}$ **(0.04)**	**0.07**$^{(*)}$ **(0.05)**	**0.5** **(0.9)**	**0.2** **(0.4)**

Coefficients that are significantly different from zero at the 1%, 5%, 10%, and 15% level are marked with ***, **, *, and $^{(*)}$ respectively. White standard errors accounting for serial correlation within firms are depicted in parantheses.

Not reported for the sake of brevity is a last robustness check, which we conducted for industry 32. Since the sub-industry 326 showed a very high number of the BW-Indicator in the year 1993, we dropped this year as a further sensitivity check. As it turns out, the estimated coefficients do not change much if this particular data point is dropped.

As such, our estimation results confirm the theoretical prediction, after which the relationship between competition and incentives is ambiguous and depends on varying countervailing effects. At least for the industries 32 and 33 of the manufacturing sector, this relationship seems to be very different indeed.

5.3 Results for Model 2

Up so far, we focused on the relationship between competition and executive compensation. Since the only testable hypothesis refers to the joint impact of competition and outside options managers on executive compensation, we now turn to the estimation

of model 2.

Precisely, Schmidt's (1997) model predicts that with increasing outside options of the mangers, an increase in competition is more likely to lead to an increase in incentives/compensation.

Table 7: Results for Industry 32, BW-Indicator*DJg

	Ind. 32 Salary	Ind.32 Salaryv	Ind.32 Salaryrel	Ind. 32 Optpc	Ind. 32 Shrownpc
Comp(BWI)*DJg	**0.0001**	**0.001****	**0.001**$^{(*)}$	**0.003**	**0.006**$^{(*)}$
	(0.0001)	**(0.003)**	**(0.0003)**	**(0.008)**	**(0.004)**
Sales	0.167***	0.389***	0.222***	1.553**	0.613
	(0.018)	(0.047)	(0.039)	(0.674)	(0.467)
ΔShareholder Value	0.085***	0.271***	0.187***	3.349***	-1.249
	(0.024)	(0.069)	(0.054)	(1.070)	(1.998)
Uncertainty	0.129*	0.649***	0.515**	16.003***	1.482
	(0.071)	(0.247)	(0.225)	(3.497)	(1.838)
DJ-growth	0.014***	0.044***	0.031***	0.424**	-0.103
	(0.003)	(0.009)	(0.009)	(0.170)	(0.064)
Optpc	-	-	-	-	-0.061***
					(0.016)
Industry-FE	Yes	Yes	Yes	Yes	Yes
Year-FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.99	0.97	0.34	0.71	0.38
Number of Observations	1326	1314	1312	1323	471

Note: Salary, Salaryv, Salaryrel, Sales and Uncertainty are in logs. Coefficients that are significantly different from zero at the 1%, 5%, 10%, and 15% level are marked with ***, **, *, and $^{(*)}$ respectively. White standard errors accounting for serial correlation within firms are depicted in parantheses.

Tables 7 and 8 depict the results for industry 32, using the BW-Indicator as a competition measure. As can be seen therefrom, an increase in competition results in higher compensation and stronger incentive payments, the better are the manager's outside options. The most significant results occur for the variable part of the salary. The better the CEO's bargaining power (in terms of general favorable economic environment (DJg) or successful past performance (BP)), the more a CEO wants to be

rewarded with a higher variable salary for the increase in competition.[24]

Table 8: Results for Industry 32, BW-Indicator*BP

	Ind. 32 Salary	Ind.32 Salaryv	Ind.32 Salaryrel	Ind. 32 Optpc	Ind. 32 Shrownpc
Comp(BWI)*BP	**0.001**	**0.010***	**0.009***	**-0.102**	**0.080**
	(0.002)	**(0.006)**	**(0.005)**	**(0.092)**	**(0.251)**
Sales	0.170***	0.398***	0.228***	1.614**	-0.153
	(0.019)	(0.047)	(0.039)	(0.686)	(1.374)
ΔShareholder Value	0.082***	0.262***	0.181***	3.355***	-11.094***
	(0.024)	(0.068)	(0.054)	(1.067)	(3.772)
Uncertainty	0.138*	0.683***	0.539**	16.341***	17.793***
	(0.071)	(0.236)	(0.216)	(3.387)	(1.861)
DJ-growth	0.015***	0.051***	0.037***	0.491**	0.362
	(0.003)	(0.010)	(0.009)	(0.170)	(0.307)
Optpc	-	-	-	-	-0.894***
					(0.256)
Industry-FE	Yes	Yes	Yes	Yes	Yes
Year-FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.99	0.97	0.34	0.71	0.66
Number of Observations	1295	1284	1282	1292	455

Note: Salary, Salaryv, Salaryrel, Sales and Uncertainty are in logs. Coefficients that are significantly different from zero at the 1%, 5%, 10%, and 15% level are marked with ***, **, *, and $^{(*)}$ respectively. White standard errors accounting for serial correlation within firms are depicted in parantheses.

Tables 9 and 10 replicate the estimations with the latent variable indicator instead of the BW-Indicator. While there is again a positive impact on the variable salary, as long as the growth rate of the Dow Jones Index is taken as a measure for the outside options, the joint impact of competition and outside options becomes insignificant, if the CEO's bargaining power is measured by past performance.

Overall, however, the picture remains that in industry 32, an increase in the bargaining power of the CEO's positively affects the relationship between competition and executive compensation.

[24]Note that the correlation between Comp(BWI)·DJg and DJg is quite low (below 30 percent) and therefore unlikely causing the positive signs.

Table 9: Results for Industry 32, LV-Indicator*DJg

	Ind. 32 Salary	Ind.32 Salaryv	Ind.32 Salaryrel	Ind. 32 Optpc	Ind. 32 Shrownpc
Comp(LV)*DJg	**0.001**	**0.004***	**0.03**	**0.006**	**0.036**
	(0.009)	**(0.002)**	**(0.002)**	**(0.057)**	**(0.028)**
Sales	0.167***	0.389***	0.222***	1.554**	0.619
	(0.018)	(0.047)	(0.039)	(0.674)	(0.465)
ΔShareholder Value	0.085***	0.271***	0.188***	3.351***	-1.242
	(0.024)	(0.069)	(0.054)	(1.070)	(2.011)
Uncertainty	0.139*	0.648***	0.514**	16.007***	1.504
	(0.071)	(0.247)	(0.225)	(3.500)	(1.834)
DJ-growth	0.014***	0.048***	0.034***	0.439***	-0.066
	(0.003)	(0.009)	(0.009)	(0.168)	(0.065)
Optpc	-	-	-	-	-0.060***
					(0.016)
Industry-FE	Yes	Yes	Yes	Yes	Yes
Year-FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.99	0.96	0.34	0.71	0.38
Number of Observations	1326	1314	1312	1323	471

Note: Salary, Salaryv, Salaryrel, Sales and Uncertainty are in logs. Coefficients that are significantly different from zero at the 1%, 5%, 10%, and 15% level are marked with ***, **, *, and $^{(*)}$ respectively. White standard errors accounting for serial correlation within firms are depicted in parantheses.

Table 10: Results for Industry 32, LV-Indicator*BP

	Ind. 32 Salary	Ind.32 Salaryv	Ind.32 Salaryrel	Ind. 32 Optpc	Ind. 32 Shrownpc
Comp(LV)*BP	**-0.001**	**-0.028**	**-0.025**	**-2.274*****	**0.218**
	(0.017)	**(0.045)**	**(0.041)**	**(0.770)**	**(0.450)**
Sales	0.170***	0.402***	0.232***	1.654**	0.652
	(0.019)	(0.047)	(0.039)	(0.685)	(0.478)
ΔShareholder Value	0.083***	0.263***	0.182***	3.255***	-1.459
	(0.024)	(0.068)	(0.054)	(1.072)	(1.885)
Uncertainty	0.140*	0.708***	0.561**	16.566***	1.660
	(0.071)	(0.238)	(0.219)	(3.394)	(1.901)
DJ-growth	0.015***	0.051***	0.036***	0.479***	-0.107
	(0.003)	(0.010)	(0.009)	(0.169)	(0.075)
Optpc	-	-	-	-	-0.057***
					(0.016)
Industry-FE	Yes	Yes	Yes	Yes	Yes
Year-FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.99	0.97	0.34	0.71	0.37
Number of Observations	1295	1322	1268	1292	455

Note: Salary, Salaryv, Salaryrel, Sales and Uncertainty are in logs. Coefficients that are significantly different from zero at the 1%, 5%, 10%, and 15% level are marked with ***, **, *, and $^{(*)}$ respectively. White standard errors accounting for serial correlation within firms are depicted in parantheses.

A similar picture arises for industry 33 (see tables 11 to 14). An increase in competition leads to a higher increase (or smaller decrease) in the variable part of the salary, if the manager's outside options are high. Note further that the joint impact of competition and outside options on the variable salary is significant or highly significant in most of the specifications.

Table 11: Results for Industry 33, BW-Indicator*DJg

	Ind. 33 Salary	Ind.33 Salaryv	Ind.33 Salaryrel	Ind. 33 Optpc	Ind. 33 Shrownpc
Comp(BWI)*DJg	**0.0001**	**0.0002**	**0.0001**	**-0.006**	**0.004**
	(0.0001)	**(0.0003)**	**(0.0003)**	**(0.005)**	**(0.003)**
Sales	0.2***	0.5***	0.29***	2.61***	-0.86*
	(0.03)	(0.036)	(0.038)	(0.64)	(0.477)
ΔShareholder Value	-0.08(*)	0.119	0.224**	2.62	4.72***
	(0.051)	(0.117)	(0.118)	(2.38)	(0.64)
Uncertainty	-0.117(*)	0.328**	0.42***	18.06***	1.8
	(0.074)	(0.15)	(0.15)	(2.86)	(1.76)
DJ-growth	0.009**	0.049***	0.039***	0.78***	0.13
	(0.003)	(0.008)	(0.008)	(0.16)	(0.073)
Optpc	-	-	-	-	-0.1***
					(0.018)
Industry-FE	Yes	Yes	Yes	Yes	Yes
Year-FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.98	0.96	0.36	0.69	0.39
Number of Observations	2425	2399	2392	2420	1240

Note: Salary, Salaryv, Salaryrel, Sales and Uncertainty are in logs. Coefficients that are significantly different from zero at the 1%, 5%, 10%, and 15% level are marked with ***, **, *, and (*) respectively. White standard errors accounting for serial correlation within firms are depicted in parantheses.

Table 12: Results for Industry 33, BW-Indicator*BP

	Ind. 33 Salary	Ind.33 Salaryv	Ind.33 Salaryrel	Ind. 33 Optpc	Ind. 33 Shrownpc
Comp(BWI)*BP	**0.002**	**0.02*****	**0.018*****	**0.2****	**-0.045**
	(0.003)	**(0.004)**	**(0.005)**	**(0.089)**	**(0.006)**
Sales	0.2***	0.5***	0.28***	2.68***	-0.8*
	(0.03)	(0.036)	(0.038)	(0.66)	(0.484)
ΔShareholder Value	-0.078$^{(*)}$	0.111	0.217*	2.4	4.65***
	(0.05)	(0.113)	(0.115)	(2.33)	(0.64)
Uncertainty	-0.112$^{(*)}$	0.28*	0.37**	17.74***	1.58
	(0.076)	(0.15)	(0.15)	(2.91)	(1.78)
DJ-growth	0.009***	0. 0.05***	0.039***	0.69***	0.029
	(0.003)	(0.008)	(0.008)	(0.157)	(0.073)
Optpc	-	-	-	-	-0.1***
					(0.018)
Industry-FE	Yes	Yes	Yes	Yes	Yes
Year-FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.98	0.96	0.34	0.69	0.38
Number of Observations	2345	2322	2315	2342	1192

Note: Salary, Salaryv, Salaryrel, Sales and Uncertainty are in logs. Coefficients that are significantly different from zero at the 1%, 5%, 10%, and 15% level are marked with ***, **, *, and $^{(*)}$ respectively. White standard errors accounting for serial correlation within firms are depicted in parantheses.

Table 13: Results for Industry 33, LV-Indicator*DJg

	Ind. 33 Salary	Ind.33 Salaryv	Ind.33 Salaryrel	Ind. 33 Optpc	Ind. 33 Shrownpc
Comp(LV)*DJg	**0.001**	**0.002**$^{(*)}$	**0.0008**	**-0.034**	**0.016**
	(0.001)	**(0.001)**	**(0.002)**	**(0.03)**	**(0.002)**
Log(Sales)	0.2***	0.5***	0.29***	2.61***	-0.86*
	(0.03)	(0.036)	(0.038)	(0.64)	(0.477)
ΔShareholder Value	-0.08$^{(*)}$	0.119	0.224*	2.62	4.72***
	(0.051)	(0.117)	(0.118)	(2.38)	(0.64)
Uncertainty	-0.117$^{(*)}$	0.327**	0.42***	18.09***	1.8
	(0.074)	(0.15)	(0.15)	(2.85)	(1.76)
DJ-growth	0.01***	0.052***	0.041***	0.71***	0.06
	(0.003)	(0.008)	(0.008)	(0.15)	(0.073)
Optpc	-	-	-	-	-0.1***
					(0.018)
Industry-FE	Yes	Yes	Yes	Yes	Yes
Year-FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.98	0.96	0.35	0.69	0.39
Number of Observations	2425	2399	2392	2420	1240

Note: Salary, Salaryv, Salaryrel, Sales and Uncertainty are in logs. Coefficients that are significantly different from zero at the 1%, 5%, 10%, and 15% level are marked with ***, **, *, and $^{(*)}$ respectively. White standard errors accounting for serial correlation within firms are depicted in parantheses.

Table 14: Results for Industry 33, LV-Indicator*BP

	Ind. 33 Salary	Ind.33 Salaryv	Ind.33 Salaryrel	Ind. 33 Optpc	Ind. 33 Shrownpc
Comp(LV)*BP	**0.008**	**0.073****	**0.057**$^{(*)}$	**0.69**	**0.14**
	(0.015)	**(0.037)**	**(0.038)**	**(0.72)**	**(0.348)**
Log(Sales)	0.19***	0.5***	0.28***	2.7***	-0.82*
	(0.032)	(0.037)	(0.038)	(0.66)	(0.49)
ΔShareholder Value	-0.077$^{(*)}$	0.118	0.22*	2.4	4.68***
	(0.05)	(0.116)	(0.117)	(2.35)	(0.65)
Uncertainty	-0.111$^{(*)}$	0.29*	0.38**	17.81***	1.49
	(0.076)	(0.15)	(0.15)	(2.92)	(1.79)
DJ-growth	0.009***	0.05***	0.041***	0.71***	0.031
	(0.003)	(0.008)	(0.008)	(0.157)	(0.073)
Optpc	-	-	-	-	-0.1***
					(0.018)
Industry-FE	Yes	Yes	Yes	Yes	Yes
Year-FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.98	0.96	0.36	0.69	0.38
Number of Observations	2345	2322	2315	2342	1192

Note: Salary, Salaryv, Salaryrel, Sales and Uncertainty are in logs. Coefficients that are significantly different from zero at the 1%, 5%, 10%, and 15% level are marked with ***, **, *, and $^{(*)}$ respectively. White standard errors accounting for serial correlation within firms are depicted in parantheses.

As for the robustness of model 2 with respect to using the lagged (joint) competition-indicator, the results look similar.[25] Only in industry 32, we observe a stronger positive impact on the fixed salary rather than the variable salary and a stronger positive impact on the equity shares. Maybe, the variable part of the salary is easier changeable in the short run, whereas re-negotiation of the fixed salary requires more time.

Including firm-fixed-effects instead of industry-fixed-effects sometimes strengthens the joint impact of competition and bargaining power on the fixed salary and the equity share, but lowers the effect on the variable salary. Again, with the exception of the option-share in table 10,[26] significant coefficients are always positive and mostly affect the fix and variable part of the salary as well as the equity shares.

[25]The robustness tests are omitted for the sake of brevity, but are available on request.

[26]The negative coefficient remains significant even with firm-fixed effects.

Therefore, for industry 32 as well as industry 33, we find results which are consistent with Schmidt's (1997) model. In fact, the bargaining power of the manager seems to be a crucial determinant of how an increase in competition affects executive compensation. Concerning the different components of executive compensation, it turns out that CEOs with a strong bargaining power particularly aim at increasing the variable salary, as soon as competition becomes more intense.

6 Conclusions

The discussion about whether competition fosters the use of incentive schemes for executives or not has been mainly theoretical so far. If there is anything like a consensus in the literature, then it is the cognition that the relationship between competition and executive compensation is ambiguous and depends on varying, countervailing effects.

The goal of this paper was to add empirical evidence to the theoretical debate. Although the desirability of empirical research was already mentioned in Schmidt (1997), the relationship between changing competition and executive compensation has not yet been explored with real data.

Focusing on firms in US manufacturing industries (NAICS 32-33) over the years 1992 to 2000, we discovered interesting effects of competition on executive compensation. For instance, in industry 32, an increase in competition led to a lower level of executive compensation (fix as well as variable) and to the use of weaker incentive schemes (lower share of variable compensation, less option and equity shares). In contrast, exactly the opposite was observed in industry 33.

The finding that competition affects executive compensation differently in different industries may be explained with the theoretical claim that countervailing effects persist. Also consistent with the literature (particularly Schmidt (1997)) is the result that outside options of the manager matter for the relationship better competition and executive compensation. During times where the economy was booming and managers had good outside options, an increase in competition affected the level of compensation and the use of incentive schemes more positively than in a recession, where the managers had no bargaining power.

Even though the results are quite robust with respect to different specifications and

different measures of competition, it is too early to draw definite conclusions. Since this is the first empirical study, more research in this area is clearly warranted. Especially applying the same type of analysis to other industries than the manufacturing industry seems to be a promising approach.

7 References

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8 Appendix

8.1 The empirical implementation of the Boone-Weigand indicator

The Boone-Weigand indicator outlined in section 3 requires data on economic profits and marginal costs, which are both not directly observable. Economic profits can be approximated by accounting profits. The main difference between economic and accounting profit is that the former are based on market values and take into account the opportunity costs of all factors of production in a forward looking way, while accounting profits are based on historical book values.

Marginal costs can be approximated by the average variable costs under the assumption of constant returns to scale.[27] This approximation may cause problems, for instance, when the quality of a product is important and cannot be observed. As a consequence, the relevant market should be defined at the lowest possible disaggregation level, i.e., the goods should be not too heterogenous. Another problem is when the firms within an industry do not meet the same condition. This is the case, for instance, when there is an import tax on products of a foreign firm, whereas the domestic firm's products are not taxed. If this tax cannot be observed, the domestic firms appears relatively more efficient. To the extent that these measurement problems with respect to marginal costs and uneven conditions stay constant over time within an industry, changes in the relative profits indicator over time can be interpreted as changes in competition in this industry.

[27] An alternative is to specify a total cost function and take the first derivative. See, e.g., Hall (1988).

Finally, note that the computation of this competition measure does not require the observation of all the firms in the industry since we can replace the values of the most efficient firms by the industry median of profits and marginal costs.

Once we accept these approximation measures, we need firm-specific data on turnover, expenses for direct labor (payroll) and materials to compute the regression variables as follows:[28]

$$profit_{it} = turnover_{it} - payroll_{it} - expenses\ for\ materials_{it} \tag{31}$$

$$av\_var\ cost_{it} = \frac{(payroll_{it} + expenses\ for\ materials_{it})}{sales_{it}} \tag{32}$$

We then compute the relative profits rel_profit_{it} and the relative costs, which we denote by relative efficiency rel_eff_{it}, by normalizing the firm specific profits and average variable costs by the median of the industry j at the 3-digit level to which the firm belongs, i.e.,

$$rel\_profit_{it} = \frac{profit_{it}}{median\ profit_{jt}} \tag{33}$$

$$rel\_eff_{it} = \frac{av\_var\ cost_{it}}{median\ av\_var\ cost_{jt}} \tag{34}$$

For each 3-digit industry in our sample we estimate the following equation:

$$\log rel\_profit_{it} = a_i + \lambda_t + \sum_{t'=t+1}^{T} b_{t'} D_{t'T} \log rel\_eff_{it'} + c \log sales_{it} + u_{it} \tag{35}$$

λ_t is a time-specific intercept, with

$$\begin{aligned} \lambda_t &= 1 \text{ for year } t = 1992, ..., 2000 \\ \lambda_t &= 0 \text{ for year } t' = 1992, ..., 2000, t \neq t' \end{aligned} \tag{36}$$

[28]In order to measure marginal costs more precisely, other costs such as expenses for debt service, taxes, depreciation, advertising, and administration may be included.

To obtain year-specific coefficients of the competition measure b, we interact the relative efficiency variable with a time dummy $D_{t'T}$, which is defined like the time specific intercept, i.e.,

$$\begin{aligned} D_{t'T} &= 1 \text{ for year } t = 1992, ..., 2000 \\ D_{t'T} &= 0 \text{ for year } t^{'} = 1992, ..., 2000, t \neq t^{'} \end{aligned} \tag{37}$$

We include sales as a control variable. The log specification controls for the skewness of the distribution. Finally, u_{it} is the remainder disturbance, with $u_{it} \sim IID(0, \sigma_u^2)$ independent of each other and among themselves.

We estimate (35) for each of the NAICS industries at the 3-digit level from the NAICS industries 32 and 33 for which there are at least 30 observations.

The NAICS industry 32 has the following seven sub-industries (see Appendix 8.2): 321, 322, 323, 324, 325, 326, 327. For the five sub-industries 322, 324, 325, 326 and 327 we have enough data, i.e., more than 30 observations, for estimating the BW-Indicator. For the NAICS industry 33, there are eight sub-industries at the three-digit level: 331, 332, 333, 334, 335, 336, 337, 339. Enough observations are available for estimating the BW-Index for five sub-industries, namely the industries 333, 334, 335, 336 and 339.

8.2 NAICS industries

NAICS 2-digit	NAICS 3-digit	industry description
32	321	Wood Product Manufacturing
	322	Paper Manufacturing
	323	Printing and Related Support Activities
	324	Petroleum and Coal Products Manufacturing
	325	Chemical Manufacturing
	326	Plastics and Rubber Products Manufacturing
	327	Nonmetallic Mineral Product Manufacturing
33	331	Primary Metal Manufacturing
	332	Fabricated Metal Product Manufacturing
	333	Machinery Manufacturing
	334	Computer and Electronic Product Manufacturing
	335	Electrical Equipment, Appliance and Component Manufacturing
	336	Transportation Equipment Manufacturing
	337	Furniture and Related Product Manufacturing
	339	Miscellaneous Manufacturing